Course Title: **Radiological Control Technician**
Module Title: **Contamination Control**
Module Number: **2.05**

Objectives:

2.05.01 Define the terms "removable and fixed surface contamination," state the difference between them and list common methods used to measure each.

2.05.02 State the components of a radiological monitoring program for contamination control and common methods used to accomplish them.

2.05.03 State the basic goal of a contamination control program and list actions that contribute to its success.

2.05.04 State the basic principles of contamination control and list examples of implementation methods.

2.05.05 List and describe the possible engineering control methods used for contamination control.

2.05.06 State the purpose of using protective clothing in contamination areas.

2.05.07 List the basic factors which determine protective clothing requirements for personnel protection.

References:

1. "DOE Radiological Control Standard"; U.S. Department of Energy, 1999.
2. "The Health Physics and Radiological Health Handbook," Scinta, Inc. 1989.
3. 10 CFR 835

Instructional Aids:

1. Overheads
2. Overhead projector/screen
3. Chalkboard/whiteboard
4. Lessons learned

I. MODULE INTRODUCTION

A. Self-Introduction

1. Name
2. Phone number
3. Background
4. Emergency procedure review

B. Motivation

Contamination control is probably one of the most difficult and challenging tasks the Radiological Control Technician will encounter.

C. Overview of Lesson

1. Types of Contamination
2. Assessing Contamination Hazards
3. Basic Goal of Contamination Control
4. Contamination Control Measures
5. Basis for Establishing Protective Clothing Requirements

D. Introduce Objectives

O.H.: Objectives

II. MODULE OUTLINE

A. TYPES OF CONTAMINATION

Objective 2.05.01

Contamination is simply defined as radioactive material in an unwanted location, e.g., personnel work areas, etc. Two types are possible:

1. Fixed Contamination - Radioactive surface contamination that is not easily transferred to other personnel or equipment through normal contact.
2. Removable Contamination - Radioactive surface contamination that is easily transferred to other personnel or equipment through normal contact.

3. Removable contamination is measured by a transfer test using a suitable sampling material. Common materials used for the monitoring are the standard paper disk smear or cloth smear. The standard technique involves wiping approximately 100 cm^2 of the surface of interest using moderate pressure. A common sampling practice used to ensure a 100 cm^2 sample is to wipe a 16 square inch "S" shape on the surface (i.e., four inches by four inches). Qualitative, large area wipe surveys may be taken using other materials, such as Masslin cloth or Kimwipe, to indicate the presence of removable contamination. These are commonly used when exact levels of contamination are not required.

4. Fixed contamination is measured by use of a direct survey technique. This technique, commonly referred to as "frisking," indicates the total contamination on a surface apparent to the detector from both fixed and removable. To evaluate the fixed component the removable level must be subtracted from the total, when non-removable levels are to be recorded.

B. ASSESSING CONTAMINATION HAZARDS

Objective 2.05.02

In order to acquire the radiological information necessary for contamination control, the presence of contamination must be identified. In order to achieve this, a radiological monitoring program must be applied. The components are:

- Constant monitoring
- Area and equipment surveys
- External personnel surveys
- Personnel internal monitoring and bioassay

1. Constant monitoring - There are various types of constant monitoring instruments installed throughout facilities to warn personnel of radiation and contamination hazards. Identify the types of instrumentation used in the constant monitoring.

   a. Some instruments are permanently installed, and some instruments are portable to allow movement from place to place as deemed appropriate.

   b. Continuous air monitor (CAM) - These instruments sample the air in specific locations continuously for radioactive contamination. Other methods of continuously monitoring for airborne contamination are also used.

1) Filter monitors draw air through a moving particulate filter, which is then monitored by a detector system.

2) Direct monitors pull air flow through an internal detector to directly identify radioactive materials present.

3) CAMs can give both a visual and audible alarm to warn personnel of the presence of airborne contamination.

c. Process monitoring systems - These systems monitor certain operations in various facilities to alert operators of abnormal conditions which might lead to the release of excessive amounts of radioactivity to the facility or environment.

2. Area and equipment surveys - Surveys are conducted routinely throughout facilities to locate sources of radiation and contamination. Pre-job surveys are performed to evaluate hazards and determine work limitations and physical safeguards within locations identified.

a. Direct instrument surveys

1) Various types of portable survey instrumentation are used to measure the presence of radioactive contamination on a floor or surface.

2) This is the only method available to detect "fixed" surface contamination.

b. Smear surveys

1) A disk smear is wiped over an area of 100 square centimeters and counted with proper instrumentation to determine the activity of the nuclides present in units of dpm/100 cm^2.

a) Disk smears are small so they are usually used in an area of suspected contamination.

b) Experience will dictate to the surveyor where contamination is most likely to occur and hence those areas that should be surveyed with disk smears.

2) Many routine contamination surveys are taken with a chemically treated cloth called a masslinn.

a) Cloth is lightly pushed over a specified areas and scanned with an appropriate detector to detect the presence of contamination.

b) If contamination is detected, a more thorough disk smear survey should be performed.

c) Large area wipes are used only as an **indication** of removable surface contamination.

d) Disk smears are required if contamination levels are to be quantified.

3. External Personnel Surveys - Personnel surveys are either performed by the individual (self-monitoring) using hand-held or automated instruments or by a RCT. Monitoring by a RCT is usually conducted whenever contamination of the body or clothing is suspected, or as required by exit monitoring when self-monitoring is not allowed. The following describes the general types of hand-held or automated instruments that are commercially available.

   a. Personnel monitors - Sensitive hand held detectors used by personnel to identify contamination on themselves whenever contamination is suspected.

      1) Portable Geiger-Mueller (GM) or scintillation detectors that are installed at strategic locations throughout the facilities.

      2) These monitors are used whenever exiting contaminated areas or RBAs.

   b. PCMs (Personnel Contamination Monitors) provide personnel with an external whole body monitoring system.

      1) PCMs are typically located at the RBA exits in facilities with a high occupancy factor.

      2) Contamination detectors within the monitors are capable of performing a survey of the whole body in a period of a few seconds, dependent upon background radiation levels and the personnel contamination limit of concern.

      3) These systems provide a more reliable method of locating personnel contamination over hand-held instruments.

c. Portal monitors - Portal monitors are "door frame" type devices which provide a final monitoring point to ensure contamination is not spread outside the facility to other facilities or the general public.

Personnel are required to use (pause and walk through) this type of monitoring system prior to exiting specified areas.

d. Personnel surveys - These are performed by RCTs whenever contamination of clothing or the body is suspected, or as required when friskers or automated instruments are not available.

1) The whole body should be surveyed with special attention given to areas which are more likely to become contaminated.

2) A minimum survey of the hands, arms, and front portions of the body must be performed upon completion of work or prior to leaving the area for glovebox, laboratory fume hood, sample station, or localized benchtop operations.

3) Contamination of the feet (shoes) would indicate removable surface contamination on the floor just traversed.

4) The nose and mouth should be surveyed upon discovery of facial contamination or if airborne contamination was detected in the work area to determine if bioassay sampling is required.

5) The nose can be swabbed with Q-tips and the swab counted in a smear counter.

6) Contamination of the nose or mouth may indicate airborne contamination.

7) All open wounds must be monitored since contaminants can be readily absorbed into the body.

8) Upon detecting personnel contamination, follow-up area and/or equipment surveys may be necessary to determine the source of contamination and the extent the contamination has spread, if any.

4. Personnel internal monitoring - A routine program of internal contamination monitoring is conducted as a final check on contamination control procedures.

Typical programs consist of external whole/partial body counting and/or urinalysis.

a. In-vivo bioassay (whole/partial body counting) - Individual is placed inside an array of very sensitive detectors to measure the activity and energies of gamma ray emissions from inside the body.

   Information can be used to determine the amount and identify the type of nuclides present.

b. In vitro bioassays - Performed by collection of urine or feces samples from an individual to determine type and activity of the nuclides present in bodily waste.

   1) Information is used to approximate the amount of nuclides present in the body by their calculated rate of elimination.

   2) Can be used to assess the presence of non-gamma emitting nuclides.

C. BASIC GOAL OF CONTAMINATION CONTROL

Objective 2.05.03

Once the presence of radioactive material has been located, the basic goal underlying any effective contamination control program is to minimize contaminated areas and maintain contamination levels as low as reasonably achievable.

1. If the presence of removable contamination is discovered, decontamination is a valuable means of control.

   a. In some situations, this is not always possible.

      1) Economical conditions: Cost of time and labor to decontaminate a location out- weighs the hazards of the contamination present.

      2) Radiological conditions: Radiation dose rates or other radiological conditions present hazards which far exceed the benefits of decontamination.

      3) Operating conditions: Some areas, e.g., hot cells, will be contaminated due to normal operations.

   b. Other means of control, such as engineering controls, administrative procedures, or personnel protective equipment, must be initiated when decontamination is not possible.

2. "Good Housekeeping" is a prime factor in an effective contamination control program. It involves the interactions of all groups within the facility. Each individual must be dedicated to keeping "his house clean" to control the spread of contamination.

   Every possible effort should be made in all operations to confine the spread of radioactive materials to the smallest possible area.

3. A sound preventive maintenance program can prevent many radioactive material releases.

4. All material taken into or out of contaminated areas should be controlled.

5. Regardless of the precautions taken, radioactive materials will occasionally escape and contaminate an area.

6. Radiological Control Technicians should always be alert for potential violations to the basic principle of contamination control.

   a. Use of improper contamination control methods

   b. Bad work practices

   c. Basic rule or procedure violations

   d. Radioactive material releases or liquid spills

7. Radiological Control Technicians should always ensure that the proper procedures to avoid the spread of contamination are followed or implemented.

D. CONTAMINATION CONTROL MEASURES

Objective 2.05.04

Objective 2.05.05

Controlling the spread of contamination is probably the most difficult and challenging task the Radiological Control Technician will encounter. The basic principles of contamination control are:

- Access/Administrative Controls
- Engineering Controls
- Personnel Protective Measures
- Decontamination
- Preventive Methods

1. <u>Access/Administrative Control</u>

Once the location of contamination has been identified and quantified and radiological areas have been established, we must adequately control access to these areas.

Boundaries of radiological areas must be clearly marked. This is accomplished by using radiological postings and tags identifying entrances into these areas to restrict access.

Two basic access control points are used in contamination control.

a. The **primary access** control point in a facility is the **entry and exit portal between the clean area and the radiologically controlled area or RBA.** The success of a control program is based on controlling the movement of personnel and equipment between these areas to prevent release of contamination to a clean location.

b. **Secondary access** control points (perhaps the most important) are set up within the RBAs to control access between surface contamination areas and non-contaminated areas. Yellow and magenta rope, tape, chain, or similar barriers are used to identify boundaries. Step-off-pads provide a recognizable demarcation to personnel between the contaminated area and the RBA.

    1) Special requirements will always be established for entry and exit through these access control points.

    2) When radiological conditions are severe, the access control point will be continuously manned by Radiological Control Technician.

    3) Proper procedures must be established and observed for crossing the SOP to prevent spread of contamination out of the area.

    4) All tools and/or equipment used in contaminated areas which are unmonitored shall be placed in plastic bags or securely wrapped in plastic before being removed from the area.

    5) All personnel and materials exiting the area shall be monitored to ensure they are free of contamination.

2. Engineering Controls - There are several specific methods of engineering control which can be utilized.

Objective 2.05.06

a. Ventilation - The design of permanent or temporary ventilation systems needs to be such that air flow is from clean areas to RBAs, to areas of moderate contamination, to areas of high contamination, and finally to a exhaust system capable of removing any contamination from the air. Slight negative pressure is typically maintained in buildings/rooms where potential contamination exists.

b. Containment - On jobs with very high contamination potential, a plastic tent, (greenhouse or hut) can be built around the work area to confine all contamination to as small an area as possible.

1) A portable ventilation exhaust system (such as HEPAs) may be used to control air flow in the containment hut and remove airborne contamination.

2) Where possible, small containment devices, such as glove boxes, glove bags, or hoods can be used to contain the contamination depending on the nature and location of the work being performed.

3) Contaminated tools or equipment are placed in plastic bags, or securely wrapped in plastic, before being moved outside a contaminated area.

4) When possible, wrapping tools or equipment prior to entry can help control contamination during use inside the contaminated area.

c. Design and Control - Design of facilities should be such that efficiency of maintenance, operations, and decontamination is maximized.

1) Components should be selected that minimizes the buildup of radioactivity.

2) Support facilities should be included that provide for the donning and doffing of protective clothing and for personnel monitoring.

3) Personnel traffic should be routed away from contaminated areas.

3. Personnel Protective Measures - If engineering methods are not adequate, then personnel protective measures, such as protective clothing and respiratory equipment, will be used.

a. The purpose of protective clothing is to keep contamination off the skin and clothing of the workers.

1) Protective clothing allows personnel to work inside a contaminated area with removable contamination and to exit the area without spreading contamination to uncontrolled areas.

2) Use of protective clothing alone will not guarantee complete elimination of personnel contamination and is not a substitute for implementing proper controls, but if used properly, protective clothing will afford a high degree of protection.

3) All personnel entering contaminated areas with removable contamination will be required to wear certain items of protective clothing.

4) Types of clothing required will vary depending upon the contamination levels and the nature of the work to be performed.

b. Some type of respiratory protective equipment will be required for work in areas where very high contamination levels exist or airborne contamination is present.

3. Decontamination - Line management is responsible for ensuring prompt decontamination, where practical, of facilities, tools, equipment, and material so that contamination can be minimized in the workplace.

Reasonable efforts should be directed toward the decontamination and unconditional release of these items rather than their disposal as radioactive waste.

4. Preventive Methods - The following are practical methods used for the prevention/control of contamination.

a. Identify and repair leaks before they become a serious problem.

b. Establish adequate work controls before starting jobs.

c. While conducting pre-job briefs, discuss measures that will help reduce or prevent contamination spread.

d. Change out gloves or protective gear as necessary to prevent cross-contamination of equipment.

e. Pre-stage areas to prevent contamination spread from work activities.

f. Cover piping/equipment below a work area to prevent dripping contamination onto less contaminated areas.

g. Cover/tape tools or equipment used during the job to minimize decontamination after the job.

h. Follow good work practices such as good housekeeping and cleaning up after jobs.

i. Confine the spread of radioactive material releases by a sound preventive maintenance program.

j. Control and minimize all material taken into or out of contaminated areas.

E. BASIS FOR ESTABLISHING PROTECTIVE CLOTHING REQUIREMENTS

Objective 2.05.07

1. The basic factors that determine the type and extent of protective clothing required are:

   a. type and form of contamination

   b. levels of contamination

   c. type of work being performed

   d. potential for increased levels of contamination

   e. the area of the body at risk

   f. competing hazards, i.e., asbestos, heat stress, etc.

2. Once the types of protection needed are established, the most efficient protective clothing must be selected from the different articles of protective clothing available for use.

   a. Whole body protection

      1) Laboratory coat

         a) Provides protection from low levels of contamination.

         b) Only applicable when the potential for body contact with contaminated surfaces is very low.

c) Lab Coats are generally worn for hands-off tours and inspections in areas with removable contamination at levels 1 to 10 times the values in Table 2-2 of the Radiological Control Standard.

d) Lab coats may also be worn during benchtop, laboratory fume hood, sample station, and glovebox operations.

2) Coveralls

a) Provides protection from low to moderate levels of **DRY** contamination.

b) Protection is low when body contact with contaminated surfaces is prolonged (since contamination can be ground into the cloth).

c) Protection is low when the surface is wet.

d) Degree of protection can be increased by use of more than one pair at a time to protect the body.

e) Not effective against radionuclides with high permeation properties (gases, tritium, etc.).

3) Plastic coveralls

a) Provides protection from high levels of dry contamination.

b) Provides protection from wet forms of contamination.

c) Provides limited protection from tritium and other highly permeating radionuclides being transported through the coveralls to the skin surface.

4) Disposable coveralls

a) Used for work involving mixed hazards, i.e., asbestos, PCBs, etc., where reuse is not desirable.

b) Types of suits are tyvek, gortex, etc. which provide moderate protection from radioactive contamination.

c) Disposable coveralls can be easily torn.

b. Hand protection

1) Surgical gloves

a) Minimal requirement

b) Normally used in only light contamination work areas

c) High degree of dexterity

d) Fairly easily torn or punctured

2) Rubber gloves

a) Lightweight

b) Provides good gripping surface

c) Normally used in moderate to heavy contamination locations

d) Greater puncture, abrasion and solvent resistance, but afford a lower degree of dexterity than surgical gloves.

3) Neoprene gloves

a) Synthetic rubber gloves mounted to various containment devices to allow access by the wearer into the device.

b) Used to provide protection for the wearer when working inside a containment device in which highly contaminated materials are present.

c) Usually of arm length attached to dry boxes, glove boxes and bags, or other cabinets.

d) Provides a gas tight seal to the structure.

e) Gloves are normally taped to the sleeve of the lab coat, coveralls, plastic suit, etc. and are tabbed to permit easy removal.

4) Cotton glove liners

May be worn inside standard gloves for comfort, but should not be worn alone or considered as a layer of protection.

5) Leather or canvas work gloves

Should be worn in lieu of or in addition to standard gloves for work activities requiring additional strength or abrasion resistance.

c. Foot protection

1) Booties: Used to protect lower leg area below coveralls from contamination. Different constructions used:

a) Plastic

b) Cloth (sometimes called cloth shoe covers)

2) Shoe covers: Worn over booties to provide a second layer of protection and provide traction to wearer.

Normally are constructed of plastic or rubber.

3. Respiratory protection

a. Full-face masks: Used to filter particulate radionuclides and/or radioactive Iodine from the breathing air of the wearer when the surrounding atmosphere is not immediately dangerous to the life and health of the wearer.

b. Supplied air systems: Used to prevent inhalation of particulate and gaseous radionuclides by the wearer in a non-life threatening atmosphere.

c. Self-contained breathing apparatus (SCBA): Used to provide a portable source of breathing air to the user when entering an atmosphere which may be immediately dangerous to life and health.

d. Medical approval, training, and fit testing are required prior to respiratory protection use.

1) Systems should be in place to verify these criteria in the field.

2) The wearer should be clean shaven in the area of fit.

3.) The wearer should perform fit checks of their respirators to ensure a proper seal.

4. Facility Protective Clothing Requirements

(Insert facility specific material here)

III. SUMMARY

A. Review major topics

1. Types of Contamination
2. Assessing Contamination Hazards
3. Basic Goal of Contamination Control
4. Contamination Control Measures
5. Basis for Establishing Protective Clothing Requirements

B. Review learning objectives

IV. EVALUATION

Evaluation should consist of a written examination comprised of multiple choice, fill-in the blank, matching and/or short answer questions. 80% should be the minimum passing criteria for examinations.